

**DIVISION OF RESEARCH, INNOVATION & SYSTEM INFORMATION**  
**Research Initial Scope of Work**  
**SUBMITTAL FORM - FY 17/18**

**I. Project Number: 1236**

Project Title: Development of Crash Reduction Factor (CRFs) for Bicycle-Related Safety Countermeasures

**II. Task Number: 3180**

Task Title: Develop quality California-specific CRFs for Bicycle-Related Safety Countermeasures.

**III. Project Problem Statement:**

With the release of the forthcoming Bicycle Safety Improvement Monitoring Program, there is a need for locally developed (i.e., California-specific) CRFs for bicycle-related safety countermeasures in order to identify the most cost-effective solution when considering various countermeasures and to evaluate their effectiveness after implementation.

“A crash reduction factor (CRF) is the percentage crash reduction that might be expected after implementing a given countermeasure at a specific site. Expected countermeasure effectiveness is also commonly expressed as a crash modification factor (CMF). A CMF is a multiplicative factor used to compute the expected number of crashes after implementing a given countermeasure at a specific site.”

(<https://safety.fhwa.dot.gov/tools/crf/>).

As stated in FHWA’s December 2010 publication *A Guide to Developing Quality Crash Modification Factors* [FHWA-SA-10-032], “CMFs can be used to:

- Estimate the safety effects of various countermeasures.
- Compare safety benefits among various alternatives and locations.
- Identify cost-effective strategies and locations in terms of crash effects.
- Check reasonableness of evaluations (i.e., compare new analyses with existing CMFs).
- Check validity of assumptions in cost-benefit analyses.

California’s State Highway Safety Improvement Program uses CRFs as part of the process for evaluating safety benefits of highway improvement projects on the State’s highway system (SHS). The State’s Highway Safety Improvement Program 2017 Guidelines (2017 HSIP Guidelines) identify specific reduction factors for various countermeasures that have been determined by analysis of past safety improvement projects on the SHS. However, there are no specific reduction factors provided in the 2017 HSIP Guidelines for bicycle-related safety countermeasures. Further, national sources (i.e., HSM, FHWA CMF Clearinghouse) lack in information regarding of safety benefits of bicycle-related safety countermeasures in California. With numerous bicycle-safety projects implemented on California public roads as of

August 2017, there is an opportunity to conduct an analysis of these countermeasures to develop CRFs.

#### **IV. Objective:**

Comprehensive research and recommendations for California-specific CRFs for bicycle safety countermeasures for common crash types and roadway types on the SHS. The intent of the proposed research is to supplement the Collision Reduction Factors for Highway Safety Projects (Table 5.1) as listed in the 2017 HSIP Guidelines.

#### **V. Task Description of Work and Expected Deliverables:**

1. Develop a list of bicycle-related safety countermeasures. This list may include the following categories and specific countermeasures:
  - Signalization Countermeasures
    - Bicycle Signal Head
    - Bicycle Signal Detection
  - Signs/Markings/Operational Countermeasures
    - Bike May Use Full Lane Sign
    - Shared Roadway Signage
    - Bicycle Route Signage
    - Begin Right Turn Lane Yield to Bike Signs
    - Intersection Warning Signs
    - Bicycle Warning Sign
    - Class I Bicycle Facility
    - Class II Bicycle Facility
    - Class III Bicycle Facility
    - Class IV Bicycle Facility
    - Addition of Buffer Adjacent to Class II Bicycle Facility
    - Bicycle Boulevard
    - Bicycle Box
    - Bicycle Lane Extension Through an Intersection
    - Two Stage Turn Queue Box
    - Signal Coordination at 15-25 MPH (Green Wave)
  - Geometric Countermeasures
    - Protected Intersection
    - Gapped Rumble Strips
    - Intersection Lighting
    - Segment Lighting
2. Determine the availability of CMFs or CRFs for the bicycle-related safety countermeasures established in (1.) The following references will be utilized to establish the CRFs:
  - i. Highway Safety Manual (HSM)
  - ii. FHWA Crash Modification Factors Clearinghouse:  
<http://www.cmfclearinghouse.org/>
    1. Only “high-quality” CRFs should will be used. The quality of the CRFs are determined using the star quality rating system utilized by the FHWA Clearinghouse. This system assigns each CRF with a numerical value on a scale of 1 to 5, where 5 is the most reliable or

highest-quality rating. High-quality CRFs are determined to be those having a rating of three stars or higher. The threshold of three stars was selected for the following reasons: it provides a relatively large list of CRFs, since the majority of CRFs in the Clearinghouse are rated three stars; it is consistent with the HSM; and it ensures that any CRF with a poor rating for one or more of the properties also has other properties with an excellent rating.

- iii. FHWA Desktop Reference for Crash Reduction Factors:  
<https://safety.fhwa.dot.gov/tools/crf/resources/fhwasa08011/>

3. Understand the applicability of CMFs or CRFs established in (2.).
4. Review the quality of the CMF established in (2.).
5. Determine research gaps in bicycle-related safety countermeasure CRFs established in (2.).
6. Select appropriate study type and design for CRF development based on research gaps established in (5.)
7. Conduct necessary research to develop California-specific bicycle-related safety countermeasure CRFs, and develop a CRF Countermeasure Table for input into 2017 HSIP Guidelines. The table will:
  - a. Provide countermeasure name and use,
  - b. Sort countermeasures into categories which may include Signalization, Pavement Markings, Signs, Geometric, and Operational Countermeasures.
  - c. Establish a fixed CRF rather than a range by establishing the conditions for which each CRF is applicable including the area type, crash type, as well as other considerations.
8. Incorporate a process to provide updates and additions to the CRF Table which will be published and maintained on the intranet for ease in updating.

## **VI. Format of Proposal:**

Proposals shall be submitted in the form of a whitepaper addressing the following elements: (1) Title; (2) Background/Introduction; (3) Draft Project Scope; (4) Examples (5) Estimated Cost; (6) General Schedule/Timeline; and (7) Contact Information.

## **VII. Background:**

California's State Highway Safety Improvement Program is a comprehensive effort to reduce the number and severity of collisions on the SHS by implementing safety improvements to existing roadways. Caltrans Headquarters analyzes collision data to develop and distribute various monitoring reports to the Districts. These reports are based on pre-established criteria which identifies locations where an engineering analysis is to be performed. Any project that results from a Monitoring Program is included in the SHOPP 201.010 Program – Safety Improvements; projects in this program are among the Department's top priority and are funded and delivered as soon as the initiation document has been approved.

The Office of Traffic Engineering's Pedestrian and Bicycle Safety Branch is developing a new monitoring program: the Bicycle Safety Improvement Monitoring

Program. This program, which will initially be implemented as a pilot program, is scheduled to be released in March 2018. The purpose of the Bicycle Safety Improvement Monitoring Program is to substantially reduce bicycle fatalities and injuries on the SHS.

With the release of the forthcoming Bicycle Safety Improvement Monitoring Program, there is a need for locally developed (i.e., California-specific) CRFs for bicycle-related safety countermeasures in order to identify the most cost-effective solution when considering various countermeasures and to evaluate their effectiveness after implementation.

#### **VIII. Estimate of Duration:** 12 months

#### **IX. Related Research:**

FHWA-SA-10-032 *A Guide to Developing Quality Crash Modification Factors*

NCHRP 20-7(314) Final Report - *Recommended Protocols for Developing Crash Modification Factors* (February 2012)

Caltrans DRISI Preliminary Investigation *Crash Reduction Factor (CRF) Update* (January 12, 2009)

Highway Safety Manual (HSM) Parts C and D

FHWA Crash Modification Factors Clearinghouse ([www.cmfclearinghouse.org](http://www.cmfclearinghouse.org))

Local Roadway Safety Manual (Version 1.3, April 2016)

#### **X. Deployment Potential:**

The deployment potential is high. There is an immediate need for locally developed CRFs as part of the forthcoming Bicycle Safety Improvement Monitoring Program.

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**Date:** August 24, 2017